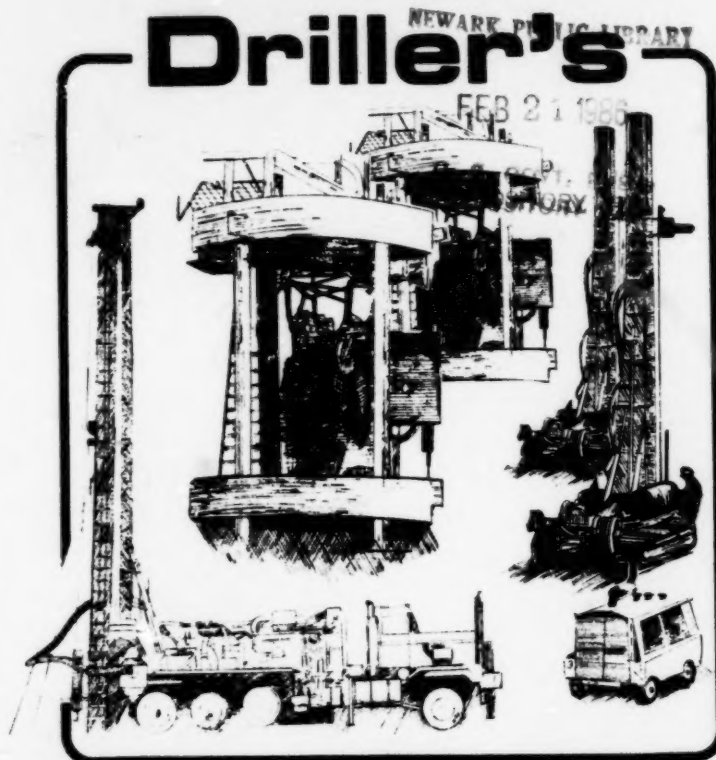


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U. S. Department of the Interior
Bureau of Reclamation

Driller's Safety Manual



Prepared by
Division of Safety
Engineering and Research Center
Denver, Colorado

Reprint 1982

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

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PREFACE

Significantly for many years safety has been our first consideration in the Bureau of Reclamation. It takes precedence over both production and cost; in fact, it comes ahead of every service we perform.

The publication of the *Driller's Safety Manual* represents a continuing effort to provide a safe and healthful work environment for all Bureau employees. The environmental health and safety standards set forth in the manual apply to earth and rock drilling operations performed by Bureau of Reclamation personnel. Bureau drilling operations are also subject to compliance with the applicable provisions of other Bureau and Federal health and safety regulations.

The Bureau of Reclamation considers health and safety standards an essential adjunct to efficient job performance, insuring that safe working conditions are maintained and safe work practices followed in all activities. While safety is considered an integral part of all Bureau operations and compliance with health and safety regulations are essential, the success or failure of the program depends on the attitudes and actions of the people doing the work.

Employees must recognize and be alert to job hazards and consciously commit themselves to performing their job safely, following established health and safety standards. The standards and safe work practices set forth in this manual were evolved from experience, and as a matter of fact were recommended by Bureau drillers and drilling supervisors. Most of the standards were learned as a result of a bitter and often traumatic experience. As a result, uncompromising compliance with established safety and health standards is considered the one infallible way to prevent accidents and injuries—THERE IS NO OTHER WAY.

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Section 1

PURPOSE AND SCOPE

1.1 GENERAL. The Driller's Safety Manual establishes safety standards and safe work practices for earth and rock drilling operations performed by Bureau of Reclamation personnel. These standards apply to selection, installation, utilization, and maintenance of drilling equipment. The type of earth and rock drilling operations covered in this manual include but are not restricted to the following: Core drilling, test hole boring, soil sampling, and investigation and research drilling. The standards do not apply to drilling powder holes for excavation.

1.2 OTHER STANDARDS. The standards and safe practices presented in this manual are necessarily selective for the purpose of facilitating reference to safe practices considered essential to performing the work safely. In addition to the standards and safe work practices set forth in this manual, Bureau drilling operations shall be carried out in compliance with the applicable provisions of the following publications: Part 365—Safety, of the Reclamation Instructions; Chapter 3, Safety Design Standards of Design Standards No. 1; Safety and Health Regulations for Construction; Power System Safety Standards; Part 1910, Occupational Safety and Health Standards (published by U.S. Department of Labor).

1.3 COMPLIANCE. Accident prevention and compliance with the safety standards and safe work practices set forth in this manual shall be fully enforced in all Bureau earth and rock drilling operations.

1.4 INTERPRETATION. As applied in this manual, the word "shall" is to be interpreted as *mandatory* and the word "should" as *advisory*.

1.5 VARIATIONS. Variations from Bureau health and safety requirements may be granted by the operating office head only when it is demonstrated to his satisfaction that equivalent protection is afforded. Such variation shall be made a matter of record and shall apply solely to a specific job situation or circumstance.

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1.8 PRIORITY. Provision for the health and safety of Bureau personnel and others and compliance with these standards and safe work practices shall take precedence over immediate job production—with **SAFETY ALWAYS THE FIRST CONSIDERATION.**

Section 2

BASIC REQUIREMENTS

2.1 DRILL SUPERVISORS

2.1.1 Responsibility. Drill supervisors and foremen shall be responsible for acquainting personnel with and enforcement of Bureau health and safety standards in their respective areas of jurisdiction and for conducting their work in a manner consistent with the highest standards of health and safety.

2.1.2 Duties. The person directly in charge of personnel performing the drilling operations is considered the foreman, regardless of payroll classification or operating title. The foreman is responsible for knowing, observing, and enforcing the safe work practices. He shall specifically outline methods and procedures for safely carrying on the work, including the proper use and maintenance of all equipment and protective devices. He shall insure that potential hazards in the immediate vicinity of the drill site are either removed, avoided by relocating the drill site, or adequately barricaded to eliminate the hazard, such as overhead or underground powerlines, oil and gas lines, or other structures. Except in cases of insubordination, he shall be held accountable for accidents that occur on work under his direction.

2.1.3 Prework Instruction. Foremen shall not permit employees to proceed with work on or in the proximity of hazardous apparatus or equipment until the employees have been instructed in the safe manner in which the work is to be performed.

2.1.4 Defective Equipment. Foremen shall not permit the use of unsafe or defective equipment, tools, or devices. They shall regularly inspect employees' tools, protective devices, equipment, and apparatus. Equipment found to be defective shall be immediately removed from use and either repaired or replaced.

2.1.5 Weekly Safety Meetings. Foreman shall conduct weekly on-the-job (toolbox) safety meetings, and timely reports of these

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meetings shall be submitted in accordance with operating office procedure. Attendance by employees at these meetings is mandatory.

2.1.6 Work Injuries. In case of an injury, the foreman or another responsible person shall see that prompt first-aid treatment is given to the victim and immediately notify his supervisor, giving such details as location, nature of injury, first-aid equipment on hand, what has been done, what is needed, name of injured person, and any other information necessary for the transportation, care, and protection of the injured person. As quickly as complete information can be assembled, a detailed report of the accident shall be prepared by the foreman or other responsible person in charge utilizing the provisions set forth in the Reclamation Instructions, Part 385-Safety, Chapter 4, Accident Investigation and Safety Reporting Procedures.

2.2 INDOCTRINATION

2.2.1 General. Foremen shall explain to all new employees safety standards applying to the assigned work and inform them that all safety standards are to be observed. Particular attention shall be given to the employees mental and physical fitness for the work he is to perform, and it shall not be presumed that he is qualified to perform the work for which he is employed.

2.2.2 Hazards. The particular hazards of the work which the employee is to perform and the precautionary measures necessary to insure his safety shall be explained in detail by the foreman. When new men are put to work, their work shall be carefully observed to determine whether it is being performed in a proper and safe manner.

2.2.3 Protection. Employees shall be familiar with the location of first-aid kits and fire extinguishers. The location and telephone numbers for emergency assistance shall be prominently posted and kept current. It is the foreman's responsibility to assure that new employees are instructed in this regard.

2-BASIC REQUIREMENTS

2.2.4 Manual. Every employee engaged in drilling operations shall be provided with a copy of the *Driller's Safety Manual*.

2.3 FIRST-AID TRAINING

2.3.1 General. Foremen and drill operators shall possess a Bureau of Mines or American Red Cross first-aid certificate. They shall also complete a refresher course at least every 3 years. (Refer to Figure 2, Mouth-to-Mouth Resuscitation.)

2.4 EQUIPMENT OPERATORS

2.4.1 Qualifications. Equipment operators shall undergo a physical examination prior to assignment and at least every 3 years thereafter to insure that they are physically qualified to safely perform their duties. Equipment operators shall be at least 20 years of age, have satisfactory hearing and visual acuity, and indicate no evidence of epilepsy, heart disease, or other impairment that would be detrimental to the safe operation of the equipment.

2.4.2 Operator's Identification Card. Prior to assignment the drill supervisor shall, through appropriate performance testing, determine the operator's qualifications and issue a Form SF-46 (Motor Vehicle Operator's Identification Card) specifying the type of equipment the employee is qualified to operate.

Section 3

PERSONAL PROTECTIVE EQUIPMENT

3.1 GENERAL. Personal protective equipment required, with the exception of leather safety shoes and boots, will be purchased by the Government and issued to employees.

3.2 SAFETY HATS. Employees engaged in operation, inspection, maintenance, survey, field geological activities, drilling operations, and other work activities where head hazards are present shall wear approved safety hats. Employees exposed to energized equipment shall wear nonconductive hard (safety) hats meeting the latest American National Standards code for head protection.

3.3 EYE PROTECTION. Eye protection shall meet American National Standard Z87.1, Safety Code for Eye and Face Protection.

3.3.1 Safety Glasses. Employees working on drilling operations shall wear prescription or plano safety glasses, fullface safety shields, or other approved-type eye protection.

3.3.2 Additional Eye Protection. Additional protection is required for work more hazardous to eyes, such as welding, cutting, chipping, grinding, sanding, riveting, or handling of chemicals and other corrosive substances as follows:

a. **Electric Welding.**—Employees engaged in electric welding operations shall wear welding helmets with lift-front or stationary-front helmets supplemented by plano or prescription safety glasses or flash goggles under helmet to provide protection when the helmet is raised for scaling operations.

Helmet filter lense shades shall conform to the following standards:

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<i>Operation</i>	<i>Welding rod diameter</i>	<i>Shade No.</i>
Shielded metal arc	1/16 to 5/32 inch	10
Shielded metal arc	3/16 to 1/4 inch	12
Shielded metal arc	5/16 to 3/8 inch	14
Inert-gas metal arc (nonferrous)	1/16 to 5/32 inch	11
Inert-gas metal arc (ferrous)	1/16 to 5/32 inch	12
Atomic hydrogen		10 to 14
Carbon arc		14

b. Gas Cutting and Welding.—Employees engaged in gas torch cutting and welding operations shall wear a welding mask, weld view or coverglass goggles, or other goggles providing equivalent protection. Goggles will be equipped with filter lenses conforming to the following standards:

<i>Operation</i>	<i>Shade No.</i>
Soldering	2
Torch brazing	3 or 4
Light cutting—up to 1 inch	3 or 4
Medium cutting—1 to 6 inches	4 or 5
Heavy cutting—6 inches or over	5 or 6
Gas welding, light—up to 1/8 inch	4 or 5
Gas welding, medium—1/8 to 1/2 inch	5 or 6
Gas welding, heavy—1/2 inch and over	6 or 8

c. Flash Goggles.—Employees engaged in welder-helper or inspection activities shall wear flash goggles as minimum protection.

d. Chemical Goggles, Clear Flexible Mask.—Employees working with or handling corrosive or molten substances shall wear chemical goggles or a face shield.

e. Coverglass Goggles, Chippers, Cover Goggles, Impact Goggles, Clear Flexible Mask.—Employees engaged in chipping, grinding,

3-PERSONAL PROTECTIVE EQUIPMENT

sanding, riveting, or any other occupation where there is a severe impact hazard shall wear a face shield, coverglass, chippers, cover or impact goggles.

3.4 FOOT PROTECTION

3.4.1 Safety Shoes or Boots. Employees engaged in drilling operations, moving heavy objects, or working in shops are encouraged to wear safety shoes or safety boots to be purchased by employees.

Where rubber boots are required, they will be furnished by the Government. All rubber footwear supplied by the Government shall have safety toes and reinforced soles or inner soles of flexible metal.

3.5 RESPIRATORY PROTECTION

3.5.1 Control. Dusts, mists, fumes, gases, or other atmospheric impurities in areas where persons are employed, and in such quantities as are determined to be harmful to health, shall be brought within safe limits by elimination, ventilation, or filtration.

3.5.2 Respiratory Devices. Where the above methods are impractical and for short periods of exposure, approved-type respiratory protective devices shall be employed as indicated in the following table published in American National Standard Practices for Respiratory Protection, ANSI Z88.2-1969:

<i>Hazard</i>	<i>Respirator</i>
1. Oxygen Deficiency	a. Self-contained breathing apparatus b. Hose mask with blower c. Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm

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Hazard

Respirator

2. Gas and Vapor Contaminants

Immediately dangerous
to life or health

- a. Self-contained breathing apparatus
- b. Hose mask with blower
- c. Air-purifying, full facepiece respirator with chemical canister (gas mask)
- d. Self-rescue mouthpiece respirator (for escape only)
- e. Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm

Not immediately dangerous
to life or health

- a. Air-line respirator
- b. Hose mask without blower
- c. Air-purifying, half-mask or mouthpiece respirator with chemical cartridge

3. Particulate Contaminants

Immediately dangerous
to life or health

- a. Self-contained breathing apparatus
- b. Hose mask with blower
- c. Air-purifying, full facepiece respirator with appropriate filter
- d. Self-rescue mouthpiece respirator (for escape only)
- e. Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm

3-PERSONAL PROTECTIVE EQUIPMENT

<i>Hazard</i>	<i>Respirator</i>
Not immediately dangerous to life or health	a. Air-purifying, half-mask or mouthpiece respirator with filter pad or cartridge b. Air-line respirator c. Air-line abrasive-blasting respirator d. Hose mask without blower
4. Combination gas, vapor, and particulate contaminants	
Immediately dangerous to life or health	a. Self-contained breathing apparatus b. Hose mask with blower c. Air-purifying, full facepiece respirator with chemical canister and appropriate filter (gas mask with filter) d. Self-rescue mouthpiece respirator (for escape only) e. Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm
Not immediately dangerous to life or health	a. Air-line respirator b. Hose mask without blower c. Air-purifying, half-mask or mouthpiece respirator with chemical cartridge and appropriate filter

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3.5.3 Bureau of Mines Approval. Respiratory devices, as described in 3.5.2 above, shall have the U.S. Bureau of Mines approval and shall be used as stipulated in the approval.

3.5.4 Hazardous to Life. Entry to areas known or suspected to be hazardous to life due to toxic concentrations or lack of oxygen shall be restricted to two or more persons wearing required respiratory protection.

3.5.5 Allowable Concentrations. Maximum allowable concentrations of atmospheric contaminants shall not be greater than the threshold limit values listed in Threshold Limit Values for Atmospheric Contaminants published by the American Conference of Government Industrial Hygienists.

3.5.6 Sampling. Where required, determination shall be made of the kind and amount of atmospheric contaminants from samples taken at a point or points in the breathing zone of workers during normal operations. Determination of the concentration and hazard of the contaminant shall be made by a qualified analyst.

3.5.7 Oxygen Deficiency. Employees shall not be permitted in atmospheres containing less than 19.5 percent oxygen unless provided with an approved-type self-contained breathing apparatus or a hose mask with blower.

3.6 EAR PROTECTION

3.6.1 Requirements. Employees working in areas or on operations determined to have high noise levels (over 90 dBA), shall wear fitted earplugs or ear-muff-type protection. Areas of high noise level will be determined by qualified technical personnel using sound level meters or octave band noise analyzers. (Refer to the Reclamation Instructions, Part 385-Safety, Chapter 10, Noise Control and Hearing Conservation.)

3.7 PROTECTIVE CLOTHING

3.7.1 Welding and Cutting. Employees doing welding or cutting shall wear leather gloves and approved leather welding apron.

3-PERSONAL PROTECTIVE EQUIPMENT

3.7.2 Chain Saws. Protective leather chaps shall be worn by employees using chain saws.

3.7.3 Rain Gear. Foul-weather gear shall be provided to employees subjected to extremely wet conditions.

3.8 SKIN PROTECTION

3.8.1 Toxic Substances. Where irritants or toxic substances may come in contact with the skin or clothing, employees shall be adequately protected by one or more of the following:

- a. Necessary protective clothing and equipment.
- b. Approved-type protective ointment for exposed skin areas.
- c. Approved solvents, soap, and hot water for the removal of toxic substances.
- d. Medically approved first-aid remedies for affected employees.

3.9 SAFETY BELTS AND LINES

3.9.1 Requirement. Employees working from unguarded heights, on steep slopes, or otherwise subjected to possible falls from heights not protected by fixed scaffolding, guardrails, or safety nets shall be secured by safety belts and lifelines.

3.9.2 Lifeline. Lifelines shall be secured to at least two substantial anchorages or structural members.

3.9.3 Manila Lifelines. Manila lifelines, used for supporting personnel on safety belts, shall be at least 1 inch in diameter. The lifeline shall be tied off to two secure anchorages. Safety lifelines used in scaling operations shall have a wire core.

3.9.4 Safety Belt Lanyards (Pigtails). Safety belt lanyards shall be 5/8-inch manila rope or equivalent securely attached to the safety belt. When used with a lifeline, the safety belt lanyard shall be

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secured to the lifeline with a scaler's hitch, as shown in Figure 3, Scaler's Hitch, or by equivalent means. Hi-scalers shall use two safety belt lanyards attached to the lifeline(s).

3.9.5 Inspection and Maintenance. Safety belts, lifelines, lanyards, and accessories shall be inspected daily when in use and maintained in safe condition.

Section 4

GENERAL REQUIREMENTS

4.1 HOUSEKEEPING

4.1.1 General. Foremen shall be responsible for good housekeeping conditions in and around the work over which they have charge.

4.1.2 Storage. Suitable storage places shall be provided for all materials and supplies.

4.1.3 Stacking. Pipe and drill rods shall be stacked on solid, level sills and secured or blocked to prevent spreading or rolling.

4.1.4 Work Areas. Work surfaces, platforms, stairways, walkways, scaffolding, and accessways shall be kept free of materials, debris, and obstructions.

4.1.5 Scrap and Waste. Scrap, waste material, and other debris shall be collected and stored in piles or containers for daily removal and disposal.

4.2 SALAMANDER HEATERS

4.2.1 General. Salamanders shall not be refueled until extinguished and permitted to cool. Heaters shall be equipped with exhaust stacks.

4.2.2 Location. Heaters shall not be set on or placed near combustible material, and they shall be shut down and permitted to cool before moving.

4.2.3 Operation. Burning salamanders shall be attended at all times, and there shall be available to each attendant suitable fire extinguishers.

4.2.4 Where tarpaulin or other flexible materials are used to form the enclosure, the material shall be fire resistant and installed to prevent contact with the heating facility.

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4.2.5 Worn salamanders which have developed holes or have been otherwise damaged shall be replaced and removed from service.

4.2.6 **Type of Fuel.** Salamanders shall be used only with approved fuels. Do not use gasoline.

4.2.7 **Stands.** Salamanders should be equipped with metal stands that will provide adequate stability and permit at least a 2-inch clearance under the unit.

4.3 EXPLOSIVES

4.3.1 **General.** The transportation, handling, and storage of powder, caps, and other blasting agents shall be performed only by or under the direction of a person of proven experience and ability in blasting operations.

4.3.2 **Regulations.** All operations with explosives shall be conducted in accordance with the regulations set forth in Safety and Health Regulations for Construction, September 1971, Part 1, Department of Labor Regulations, Subpart U—Blasting and Use of Explosives.

4.3.3 **Storage Magazines.** Small trailer-mounted storage magazines shall be constructed of a minimum of 2-inch tongue-and-groove hardwood, covered with 1/4-inch steel, and secured to the frame of the trailer. The distance between magazines shall be no less than 30 inches. These units shall not be used to transport explosives. Once the unit is located near the worksite, the wheels should be removed to reduce the chance of theft. This method of storing small amounts of explosives at drilling sites provides greater security, better magazines, and facilitates the moving of the magazines. Other type explosive magazines shall be constructed in accordance with the bulletin published by the Institute of Makers of Explosives and shall be licensed in the state in which they are used.

4.4 LIGHTING

4.4.1 **General.** In addition to providing required or recommended illumination intensities of at least 5 foot-candles, consideration

4-GENERAL REQUIREMENTS

should be given to the selection and placement of lighting equipment which will provide minimum glare and well-lighted vertical and oblique surfaces, eliminate harsh shadows, and provide adequate illumination to perform the work efficiently and safely.

4.4.2 Light Bulbs. Light bulbs shall be heavy duty, outdoor, nonshattering type.

4.4.3 All lighting circuits including drop cords shall be grounded.

4.4.4 Inspection. Lighting circuits shall be inspected periodically and defective wiring or fixtures removed from service.

4.5 FLAMMABLE LIQUIDS

4.5.1 Storage and Handling. Gasoline and other highly flammable liquids shall be stored and handled only in approved-type containers. Portable containers shall be approved-type red safety containers equipped with flame arresters and self-closing lids.

4.5.2 Hand Pumps. Approved-type hand pumps shall be used to dispense gasoline from barrels.

4.5.3 Gasoline. Gasoline shall NOT be used for degreasing or to start fires.

4.5.4 Precautionary Measures. Gasoline containers shall be labeled and storage areas posted with "No Smoking" signs. Foam, carbon dioxide, or dry chemical fire extinguishers shall be installed in these areas.

4.6 FIRE PROTECTION

4.6.1 General. It is the responsibility of the foreman to see that good housekeeping practices are followed and that his men observe all fire prevention regulations and understand the proper methods of extinguishing Class A, B, and C fires. Fire-extinguishing equipment shall be routinely checked, filled, and ready for instant use.

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4.7 PUBLIC SAFETY

4.7.1 General. Foremen shall so regulate their work that the public will be protected from injury or accident. Adequate danger signs or barriers, etc., shall be so placed that they will effectually warn the public of hazards and restrict access to danger areas.

Section 5

DRILLING EQUIPMENT

5.1 SKID-MOUNTED UNITS

5.1.1 Control Levers. Labels clearly indicating the function and direction of the control levers shall be posted on the power unit controls of all drills.

5.1.2 Safety Shutoff. An emergency safety power shutoff device shall be installed within reach of the operator on all units. The device shall be clearly labeled or otherwise made readily identifiable and checked daily to insure that it is operable.

5.1.3 Operator. The power unit shall be operated only by authorized and qualified persons instructed in the operation of the particular equipment.

5.1.4 Lubrication and Repair. Equipment shall be shut down during manual lubrication and while repairs or adjustments are being made.

5.1.5 Refueling. Internal combustion engines shall NOT be refueled while running. Where practicable, the gasoline tank should be positioned or shielded to avoid accidental spillage of fuel on the engine or exhaust manifold during refueling operations.

5.1.6 Unit Controls. Wherever practicable, operating unit controls shall be designed to return to neutral when the control levers are released.

5.1.7 Gears and Moving Parts. Gears and moving parts, constituting a hazard to workmen, shall be shielded to prevent accidental contact.

5.1.8 Fire Extinguishers. A dry chemical or carbon dioxide fire extinguisher, rated 5 pounds or larger, shall be carried on the unit and removed to a position within 25 feet of the worksite during

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drilling operations. Extinguishers shall be inspected and tagged at least once every 3 months.

5.1.9 Exhaust Systems. Engine exhaust systems shall be equipped with spark arresters when operated in areas where sparks constitute a fire hazard.

5.2 SITE SELECTION AND WORKING PLATFORMS

5.2.1 Preparing Worksite. Adequate clearing shall be done to accommodate the drill platform and supplies.

In preparing a worksite located on adverse topography, precautions against caving, slides, and loose boulders must be taken. The drill platform shall be stabilized by outriggers or adequate timbering.

5.2.2 Transmission Lines. In the vicinity of power transmission or distribution lines, drills shall be set with at least a 15-foot clearance between any part of the drill or mast and the powerline. Further, the drill shall be adequately grounded.

5.2.3 Drainage. A drain shall be provided for the drill water to flow from the worksite. The drain shall be extended far enough from the worksite to prevent any undercutting of the foundation.

5.2.4 Toilets. Toilet facilities shall be conveniently available to drill crews. Toilets shall be either chemical type or constructed over ground pits which shall be backfilled when abandoned. They shall be fly tight, kept clean, and maintained in a sanitary condition.

5.2.5 Drill Platform Design. Drill platforms shall be designed to provide adequate working space.

5.2.6 Lumber for Drill Platform. Lumber used in constructing the drill platform shall be of good quality, straight grained, and free of unsound checks or knots.

5.2.7 Sill Size. Sills supporting the working deck shall be 4- by 4-inch nominal dimension or greater, spaced on 4-foot centers or less.

5-DRILLING EQUIPMENT

5.2.8 Decking Sills. Decking sills should be spaced so that there is no overhang.

5.2.9 Deck Boards. Deck boards shall be at least 2- by 10-inch nominal dimension and secured to the sills to prevent movement.

5.2.10 Mud Pits and Drainage Excavations. Mud pits and drainage excavations should be safely sloped and located to provide minimum interference with work. Where necessary, suitable barricades, catwalks, etc., should be provided to reduce the possibility of injury to persons. Ladders shall be positioned in pits or excavations 5 feet or greater in depth.

5.3 WOODEN MASTS AND DERRICKS (TRIPOD)

5.3.1 Tripod Timbers. Tripod timbers, 34 to 38 feet in length shall have a minimum dimension of 8 inches at the base and 4 inches at the top. (Refer to Figure 1.)

5.3.2 Banding of Timbers. Tips of tripod timbers shall be encircled with a steel band or bound with wire to prevent splitting. (Refer to Figure 1.)

5.3.3 Securing Tripod Timbers to Deck. Tripod timbers shall be secured to the deck to prevent slipping. Quarter-inch chain or cable shall be used to secure the deck poles to the mast timbers. (Refer to Figure 1.)

5.3.4 Work Platforms. Work Platforms with 42-inch-high handrails and toeboards shall be installed on the upper decks of the tripod masts. The decking shall consist of a nonskid surface. For added safety, a rope shall be attached to the tripod approximately shoulder height.

5.3.5 Access Ladders. Ladders shall be provided and securely attached to the deck poles to provide access to the work platforms.

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5.4 TRUCK-MOUNTED DRILLS

5.4.1 General. Platforms, steps, handholds, and guardrails shall be provided on the equipment to assure safe access and footing. The platform and decks shall be coated with nonskid surface.

5.4.2 Preventive Maintenance. An effective preventive maintenance program providing for periodic inspection at such intervals as are necessary, to insure safe operation and adequate maintenance, shall be carried out.

5.4.3 Safety Line. Truck-mounted drills shall be equipped with a "Safety Line" or with clearly marked and conspicuously located emergency switches (panic buttons). The "Safety Line" emergency stop consists of a taut wire that runs around the back of the machine and connects to a special switch that turns off the power unit when the line is contacted. When emergency switches are used in lieu of a "Safety Line" there shall be a minimum of two. One switch is to be located within easy reach of the operator and one located within easy reach of helpers at ground level near the drill or auger head.

5.4.4 Truck Movement. Trucks shall NOT be moved backwards, unless the driver has personally inspected the area behind the truck. In restricted or congested areas or areas where workmen are located, the assistance of a "spotter" is mandatory. Trucks shall be equipped with serviceable automatic backup alarms.

5.4.5 Raising Mast. Before raising the mast, personnel shall be cleared from the immediate area with exception of the operator and a helper when necessary. A check shall be made to insure safe clearance from energized powerlines or equipment. Unsecured equipment shall be removed from the mast before raising. Cables, mud lines, and cat line ropes must be adequately secured to the mast before raising.

5.4.6 Securing Mast to Rig. After raising, the mast shall be secured to the rig in an upright position with steel pins.

5.4.7 Moving Drill Equipment. Prior to moving drill equipment a thorough inspection shall be made to insure that the mast, drill rods,

5-DRILLING EQUIPMENT

tools, and other supplies and equipment are secured to prevent displacement while in transit. Applicable traffic laws shall be observed in moving drill equipment over public roads. A check shall be made of steering mechanism, brakes, lights, load limits, and proper flagging or lighting of load extensions.

Section 6

SURFACE DRILLING OPERATIONS

6.1 GENERAL. Before starting the power unit, all gears shall be disengaged, cable drum brake set, and no rope shall be in contact with the cathead.

6.2 SAFETY CHAINS. A safety chain and cable arrangement shall be used to prevent water swivel and mud line whip.

6.3 WATER SWIVELS AND HOISTING PLUGS. All water swivels and hoisting plugs shall be checked for possible frozen bearings and shall be properly lubricated before use. A frozen bearing could cause mud line whip and injury to the operator.

6.4 BRAKING OPERATION. Only the drill operators shall brake or set the chucks, to eliminate the possibility of engaging the transmission prior to removing the chuck wrench.

6.5 CHUCK JAWS. The chuck jaws shall be periodically checked and replaced as necessary.

6.6 STRING OF DRILL RODS. A string of drill rods should NOT be braked, during lowering into the hole, by the chuck jaws. A cat line or hoisting cable and plug should be used for braking prior to tightening of the chuck. Failure to follow this procedure will result in steel slivers on the rods, possible hand injuries, and loss of the rods down the hole.

6.7 LOWERING DRILL RODS. Drill rods shall NOT be lowered into the hole with a pipe wrench. Serious back and hand injuries may result if the rods are lowered by this method.

6.8 DRILLING WITH AIR. When drilling with air, the exhaust and cuttings shall be directed to the side away from workmen.

6.9 CLEANING DRILL RODS. When using drilling fluids, a rubber or other suitable wiper shall be used to remove the material from the drill rods when removing them from the drill hole.

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6.10 PIPE WRENCH JAWS. Pipe wrench jaws should be checked periodically and replaced as they become worn.

6.11 DRAINING OF DRILL RODS. Drill rods should be allowed to drain completely following braking before removal from the working area.

6.12 HOISTING OF DRILL ROD. Care must be exercised by the operator to avoid a sudden hoist release of the drill rod while the rod is being carried from the hole.

6.13 HOIST CAPACITY. The hoisting capacity and weight of the drill rod must be known to prevent collapse of the mast during drill string removal from the hole. The operating capacity of the mast and hoist shall NOT be exceeded.

6.14 CLEANING OF AUGER FLIGHTS. Cleaning of auger flights shall NOT be done while the auger is rotating. A special paddle should be designed for cleaning auger flights or, if available, water under pressure is recommended for jet cleaning.

6.15 AUGER SECTIONS. The use of mismatched auger sections should be avoided. Different brands and different weights shall NOT be used in the same auger flight.

6.16 FITTING PINS. Only tight-fitting pins designed for the auger shall be used. Some pins lose their temper after very little use and the spring or clip section fails to hold the pin securely.

6.17 DRILL HOLE PROTECTION. Unattended drill holes shall be adequately covered or protected to avoid the possibility of animals or people accidentally falling into them.

6.18 EQUIPMENT INSPECTION. Daily inspections prior to using equipment shall be made. This inspection should include a thorough check of the hydraulic hoses, connections, and valves. Deficiencies should be corrected or safe condition verified before starting the equipment.

6-SURFACE DRILLING OPERATIONS

6.19 WARNING SIGNS. A durable warning sign shall be installed on all equipment in full view of the operator containing the following wording:

1. All *personnel must be clear* before starting machine.
2. Stop the auger to clean it.
3. Stop engine when repairing, lubricating, or refueling.
4. Do not wear *loose fitting clothing or gauntlet-type gloves*.

Section 7

UNDERGROUND DRILLING OPERATIONS

Note: In addition to the following safe practices, refer to Safety and Health Regulations for Construction, September 1971, Part I, Department of Labor Regulations, Subpart S—Tunnels and Shafts, Caissons, Cofferdams, and Compressed Air, which apply to all Bureau operations.

7.1 ACCESS. Safe means of access shall be provided and maintained to all underground working places.

7.2 LOWERING AND HOISTING EQUIPMENT IN SHAFTS. Heavy equipment shall NOT be carried down ladders into a shaft. Mechanical hoisting devices shall be provided for lowering and hoisting equipment in a shaft exceeding 50 feet in depth.

7.3 UNATTENDED SHAFTS. Access to unattended shaft openings shall be restricted by barricades equipped with gates or doors. Subsidence areas that present hazards shall be fenced and posted.

7.4 EVACUATION PLAN. Prior to a startup, evacuation plans and procedures shall be developed and made known to all employees.

7.5 UNDERGROUND VENTILATION. Underground work areas shall be mechanically ventilated providing a minimum air exchange of 200 cubic feet per minute for each employee.

7.6 SCALING WORK AREAS. Work areas shall be thoroughly scaled prior to any drilling operations and periodically during all underground work.

7.7 WALKWAY. A clear walkway must be maintained and no equipment or materials shall be permitted to obstruct the passageway.

7.8 DRAINAGE. Drainage away from the worksite should be provided and maintained.

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7.9 LIGHTING. Sufficient lighting shall be installed and maintained in work areas and access ways. A minimum illumination intensity of 5 foot-candles is required in work areas.

7.10 ELECTRIC SERVICE LINES. Electrical service lines shall be well insulated, strung on insulators, and separated from water, air, or telephone lines.

7.11 HARDHATS. Employees shall wear nonconductive insulated hardhats.

7.12 DUST RESPIRATORS. Bureau of Mines approved dust respirators shall be worn when dust concentrations exceed the safe hygiene limits.

7.13 MINER'S LAMPS. Unless a lighting system has been installed, miner's lamps shall be provided and worn by all employees working underground.

7.14 EAR PROTECTION. Ear protection shall be worn when sound level exposure exceeds 90 dBA.

7.15 RAIN CLOTHING. Rubber rain suits shall be provided and worn where conditions warrant.

7.16 ANCHORS. Installation of rock bolts for anchoring or pulling devices must be done in accordance with approved mine safety standards. All rock bolts shall be adequately torqued in accordance with manufacturers' recommendations.

7.17 COLUMN MOUNT DRILL UNITS. All column mount drilling units shall be securely stabilized with necessary timbers and wedges adjacent to column footplates. Wedges shall be driven to place and nailed to adjacent timbers to prevent vibration movement.

7.18 FLAMMABLE LIQUIDS OR GASES. Except for welding and cutting, no flammable liquids or gases shall be allowed underground.

7-UNDERGROUND DRILLING OPERATIONS

7.19 AIR LINES. Air lines exceeding one-half inch in diameter shall be equipped with safety-type couplings and secured with wire or chain at each coupling to prevent whipping in event of failure. Air hoses shall NOT be disconnected until shut off and bled to reduce the pressure.

Section 8

HANDTOOLS AND PORTABLE POWER TOOLS

8.1 GENERAL

8.1.1 Repair and Use. Handtools shall be kept in good repair and used only for the purpose for which designed.

8.1.2 Defective Tools. The use of tools with mushroomed heads, split or defective handles, worn parts, or other defects shall NOT be permitted. Tools that have become unsafe shall be reconditioned before reissue or shall be discarded.

8.1.3 Storage. When NOT in use, tools shall NOT be left on scaffolds, ladders, or overhead working spaces. Containers shall be provided to hold tools and prevent them from falling. Unguarded sharp edged or pointed tools shall NOT be carried in employees' pockets.

8.1.4 Throwing or Dropping Tools. Throwing or dropping tools from one level to another shall NOT be permitted. Containers and handlines shall be used for transporting tools from one level to another.

8.1.5 Nonsparking Tools. Nonsparking tools shall be used in atmospheres where sources of ignition may cause a fire or explosion.

8.1.6 Grounding. Electric-powered shop and handtools shall be of double-insulated shockproof type or be effectively grounded.

8.1.7 Designated Operators. Power tools shall be operated only by designated employees familiar with their use.

8.2 GRINDING TOOLS

8.2.1 Guards. Portable grinders shall NOT be used without safety guards properly installed. Guards and tool rests shall be maintained in proper adjustment.

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8.2.2 Grinding Wheels. Grinding wheels shall NOT be operated at speeds in excess of the manufacturer's safe ratings. Cracked or defective wheels shall not be used.

8.2.3 American National Standards Institute, Inc. The use and care of abrasive wheels and disks shall be governed by American National Standard B7.1, Safety Code for the Use, Care, and Protection of Abrasive Wheels and Disks.

8.3 POWERSAWS

8.3.1 Guards. Portable circular powersaws shall be equipped with guards that automatically enclose the cutting edges.

8.3.2 Defective Blades. Cracked or defective blades shall not be used.

8.3.3 Unattended. Powersaws shall not be left running when unattended.

8.4 PNEUMATIC TOOLS

8.4.1 Inspection and Maintenance. Portable pneumatic power tools shall be inspected periodically to assure good mechanical condition.

8.4.2 Impact Tools. Pneumatic impact tools shall be operated with safety clips or retainers installed to prevent tools from being accidentally discharged from the chuck.

8.4.3 Airhoses. Airhoses shall not be disconnected from equipment until the pressure has been shut off and exhausted from the line. Safety lashing shall be provided at all hose and tool connections on air lines over one-half inch in diameter. Leaking or defective hose shall be replaced.

Section 9

ROPES, CHAINS, AND ACCESSORIES

9.1 GENERAL

9.1.1 Safety Factor. The use of ropes and chains shall be governed by the instructions on usage and safe limits as recommended by the manufacturer. (See Table 1 for required safety factors.)

9.1.2 Inspection. Ropes and chains shall be inspected before use, and their loading shall NOT exceed the safe limits set forth by the manufacturer or as set forth in Tables 1, 6, and 7.

9.1.3 Safety Hooks. Hooks used in hoisting personnel or hoisting loads over workmen or in the immediate vicinity of workmen shall be forged steel equipped with safety keepers. When shackles are used under these conditions, they shall be of the locking type or the pin secured to prohibit turning.

9.1.4 Hooks, Headache Balls, and Lifting Accessories. Load lifting accessories, such as sheaves, shackles, hooks, headache balls, and similar accessories designed for the intended loading shall be obtained from a reputable manufacturer. Use of the job-fabricated lifting accessories, as described above, is expressly prohibited.

9.1.5 Inspection and Removal from Service. Hooks, shackles, sheaves, rings, pad eyes, and similar accessories which show excessive wear, or that have been bent, twisted, or otherwise damaged shall be removed from service.

9.1.6 Repair and Maintenance. The installation, maintenance, and repair of ropes and chains shall be done only by qualified persons.

9.2 SLINGS

9.2.1 Inspection. Slings, when in use, shall be inspected daily by a qualified person for signs of overloading, excessive wear, or damage. Defective slings shall be removed from service and repaired or replaced before reuse.

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9.2.2 Storage. Proper storage shall be provided for slings when not in use to insure against any damage that would impair their strength.

9.2.3 Protection in Use. Slings shall be protected from sharp, rough, or square corners by appropriate means to prevent cutting or breaking of fibers, strands, or chain links.

9.2.4 Capacity. Refer to Table 1 for the effect of the angle of sling on the capacity of each leg.

9.3 WIRE ROPE

9.3.1 Inspection. The safe performance of wire rope or cables can be assured only by rigid periodic inspection and through proper use and care. Wire hoisting rope shall be inspected by a competent person at the time of installation and at least once each week when in use.

9.3.2 Safety Factor. The maximum allowable loads for wire hoisting rope shall not exceed the safe working load prescribed by the manufacturer, or the ultimate strength of the rope divided by the safety factor set forth in Table 1. (Refer to Tables 1 and 5.)

9.3.3 Accessories. Commercial end-fastenings, clips, and zinc sockets shall be properly applied to develop maximum strength. See Tables 2 through 4 for required installation and strength data.

9.3.4 Removal from Service. Wire rope shall be removed from hoisting or load-carrying service when kinked or when any one of the following conditions exist:

- a. Twelve randomly distributed broken wires in one rope lay or four broken wires in one strand in one rope lay.
- b. Evidence of corrosion or heat damage.
- c. One broken wire, rust, or corrosion adjacent to a socket or end fitting (this requires removal from service or resocketing).

9-ROPES, CHAINS, AND ACCESSORIES

d. Abnormal reduction in diameter, distortion, stretching, or elongation.

9.3.5 Marking Defective Wire Rope. Wire rope found defective for hoisting or load-carrying service shall be plainly marked as being unfit for such use.

9.3.6 Guarding. Running lines of hoisting equipment located within 8 feet of the ground or working level shall be guarded or the operating area restricted.

9.3.7 Sheave Diameter. The ratio between the rope diameter and the drum or sheave diameter shall not be less than the recommended values contained in Table 4 or as specified by the equipment manufacturer. Drums, sheaves, and pulleys shall be smooth and free from surface defects liable to injure rope.

9.3.8 Connectors. Rope clips attached with U-bolts shall have the U-bolts on the dead end of the rope. For the proper size and number of U-bolts required, see Table 3.

9.3.9 Wedge Fasteners. When a wedge-socket fastening is used, the dead or short end of the cable shall be clipped to the live cable with U-bolt or other approved type of fastener.

9.4 FIBER AND SYNTHETIC-FIBER ROPE

9.4.1 Quality. In selecting fiber and synthetic-fiber ropes for load-carrying purposes, only the best quality rope shall be used with sizes and application in accordance with the manufacturer's recommendations.

9.4.2 Inspection. Ropes shall be inspected frequently to insure safe performance.

9.4.3 Care. Proper care shall be given ropes in order to maintain good condition and high strength capacity. Fiber ropes should NOT be allowed to freeze after becoming wet but should be carefully cleaned and dried in loose coils.

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9.4.4 Acids and Alkalies. Ropes shall not be stored close to cement, lime, acids, or alkalies. Ropes that have been exposed to these materials shall be removed from service.

9.4.5 Rope Properties. Tables 6, 7, and 8 contain properties, breaking strengths, and safe loads for manila and synthetic fiber rope.

9.5 CHAINS

9.5.1 Use and Inspection. Extreme care is necessary in the use and maintenance of all load-carrying chains, and they shall be inspected by a competent person after each installation and regularly thereafter.

9.5.2 Safe Load. The safe load on chains shall be determined from capacity tables issued by the chain manufacturer. Chains shall NOT be subjected to a load greater than their rated safe loading. (See Table 1 for minimum safety factors.)

9.5.3 Impact Loading. Chains should not be subjected to impact loads or jerking.

9.5.4 Repair. Repair to chains shall be made by qualified persons or by the manufacturer. Annealing of load-carrying chains shall be done only by the manufacturer, or in strict accordance with manufacturer's recommendations.

9.5.5 Makeshift Repair Prohibited. Splicing broken chains by inserting a bolt between two links with the heads of the bolt and the nut sustaining the load, or passing one link through another and inserting a bolt or a nail to hold it, is prohibited.

TABLES AND FIGURES

TABLE 1.—MINIMUM SAFETY FACTORS—ROPES,
CABLES, CHAINS AND ACCESSORIES.

Type of service	Wire rope	Manila or synthetic rope	Chain
Guy lines	3.5	3.5	3.5
Slings	5.0	8.0	8.0
Hoisting equipment*:			
Standing lines and parts	5.0		
Hoisting and running lines	3.5	(Refer to Tables 6 and 7)	
Shackles, hooks, and accessories	3.5	3.5	3.5

*Or as specified by the equipment manufacturer.

HOW ANGLE OF SLING AFFECTS THE CAPACITY OF
EACH LEG

Angle (A)	Efficiency (percent)	Angle (A)	Efficiency (percent)
90°-----	100	50°-----	76
80°-----	98	45°-----	71
70°-----	94	40°-----	64
65°-----	91	35°-----	57
60°-----	87	30°-----	50
55°-----	82	5°-----	8½



Note: To determine safe load for a single line, divide the breaking strength of the line by the applicable safety factor and multiply the result by the percentage factor indicated in the above table. Slings shall not be attached in such a manner as to provide an angle of less than 30° between the sling leg and the horizontal.

TABLE 2.—EFFICIENCY OF WIRE ROPE CONNECTIONS
AS COMPARED TO SAFE LOADS ON WIRE ROPE.

Figure	Type of connection	Efficiency
1	Sockets - Zinc type - properly attached	100%
2	Wedge sockets	70%
3	Cable clips	80%
4	Plate clamp - three-bolt type	80%
*5	Knot and clip (prohibited)	50%
6	Spliced eye and thimble	
	1/4 inch and smaller diameter	90%
	5/16 to 7/16 inch	88%
	1/2 inch	86%
	5/8 inch	84%
	3/4 inch	82%
	7/8 inch and larger diameter	80%



Figure 1



Figure 2



Figure 3



Figure 4



Figure 5



Figure 6

**TABLE 3. — INSTALLATION OF CABLE CLIPS
ON WIRE ROPE.**

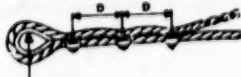
NUMBER OF CLIPS AND THE PROPER TORQUE NECESSARY
TO ASSEMBLE WIRE ROPE EYE LOOP CONNECTIONS WITH A
PROBABLE EFFICIENCY NOT MORE THAN 25 PERCENT

Rope diameter (in.)	Nominal size of clips	Number of clips	Torque to be applied to nuts of clips (ft-lbs)
$\frac{1}{8}$	$\frac{1}{8}$	3.....	25
$\frac{1}{4}$	$\frac{1}{4}$	3.....	25
$\frac{1}{2}$	$\frac{1}{2}$	4.....	40
$\frac{3}{4}$	$\frac{3}{4}$	4.....	40
$\frac{7}{8}$	$\frac{7}{8}$	4.....	65
1	1	4.....	100
$1\frac{1}{8}$	$1\frac{1}{8}$	5.....	165
$1\frac{1}{4}$	$1\frac{1}{4}$	5.....	165
$1\frac{3}{4}$	$1\frac{3}{4}$	6.....	250
2	2	6.....	375
$2\frac{1}{4}$	$2\frac{1}{4}$	6.....	375
$2\frac{3}{4}$	$2\frac{3}{4}$	6.....	560

The spacing of clips should be six times the diameter of the wire rope. To assemble a satisfactory end to end connection, the number of clips indicated above should be increased by two, and the proper torque remain unchanged.

How to Attach Wire Rope Clips

U-Bolt Clip



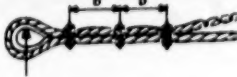
Thimble

U-Bolt of all clips on dead end of rope.

Never stagger clips.

Never put U-Bolt of clip on live end of rope.

Flat Grip Clip



Thimble

Note. D=six times diameter of wire rope.

TABLE 4. — POURED SOCKET TERMINALS FOR WIRE ROPE AND RECOMMENDED SHEAVE DIAMETERS

RECOMMENDED PRACTICE-POURED SOCKET TERMINALS FOR WIRE ROPE

Socket preheat temperature	Zinc pouring temperature	Wire rope size range
500° F	900° F	¼" to ½" incl.
100° F	900° F	¾" to 2" incl.

Use 1.1.1 Trichloroethane as the degreasing material for cleaning wire rope ends prior to socketing.

Probable efficiency of a new and properly prepared zinc socket is 100 percent.

The use of babbitt is prohibited for poured sockets.

SHEAVE DIAMETERS FOR OPERATING WIRE ROPES

Wire rope construction	Recommended sheave diameter	Minimum sheave diameter
6 strands of 7 wires	72 times rope diameter ..	62 times rope diameter.
6 strands of 19 wires	65 times rope diameter ..	50 times rope diameter.
6 strands of 37 wires	57 times rope diameter ..	38 times rope diameter.
8 strands of 19 wires	51 times rope diameter ..	31 times rope diameter.
18 strands of 7 wires	51 times rope diameter ..	34 times rope diameter.

TABLE 5. — PROPERTIES OF WIRE HOISTING ROPE.

BREAKING STRENGTH OF 6 X 19 STANDARD WIRE HOISTING ROPE ¹

Diameter (in.)	Approximate weight per 100 feet (lb.)	Breaking strength ² (tons of 2,000 pounds)		
		Mild plow steel	Plow steel	Improved plow steel
¼.....	10	2.07	2.39	2.74
⅜.....	23	4.62	5.31	6.10
½.....	40	8.13	9.35	10.7
¾.....	63	12.6	14.5	16.7
1.....	90	18.0	20.7	23.8
1 ¼.....	123	24.3	28.0	32.2
1 ½.....	160	31.6	36.4	41.8
1 ¾.....	203	39.8	45.7	52.6
2.....	250	48.8	56.2	64.6
2 ¼.....	360	69.6	80.0	92.0

¹ 6 x 19 wire rope means rope composed of 6 strands of 19 wires each. The strength of wire rope varies slightly with the strand construction and number of strands.

² The maximum allowable working load is the breaking strength divided by the appropriate factor of safety.

TABLE 6.-SAFE LOADS ON NEW THREE-STRAND MANILA ROPE*.

Diameter in inches	Circumference in inches	Approximate weight per foot in pounds	Single rope		Two-part sling		
			Breaking strength, pounds	Safe load, pounds			
1/4	3/4	0.020	600	120	210	170	120
3/8	1-1/8	0.041	1,350	270	470	380	270
1/2	1-1/2	0.075	2,650	530	920	750	530
5/8	2	0.133	4,400	880	1,520	1,245	880
3/4	2-1/4	0.167	5,400	1,080	1,870	1,530	1,080
7/8	2-3/4	0.225	7,700	1,540	2,660	2,180	1,540
1	3	0.270	9,000	1,800	3,110	2,545	1,800
1-1/8	3-1/2	0.360	12,000	2,400	4,150	3,395	2,400
1-1/4	3-3/4	0.418	13,500	2,700	4,670	3,820	2,700
1-1/2	4-1/2	0.600	18,500	3,700	6,400	5,230	3,700
1-5/8	5	0.744	22,500	4,500	7,785	6,360	4,500
1-3/4	5-1/2	0.895	26,500	5,300	9,170	7,495	5,300
2	6	1.08	31,000	6,200	10,725	8,770	6,200

*Note. Breaking strength and safe loads given are for new rope used under favorable conditions. As rope ages or deteriorates, progressively reduce safe loads to one-half of values given.

TABLE 7.-SAFE LOADS ON NEW SYNTHETIC FIBER ROPE*

Diameter in inches	Circumference in inches	Nylon		Polypropylene			
		Weight per 100 feet, pounds	Breaking strength, pounds	Safe load, pounds	Weight per 100 feet, pounds	Breaking strength, pounds	Safe load, pounds
1/4	3/4	1.54	1,500	300	1.16	1,200	240
3/8	1-1/8	3.5	3,500	700	2.78	2,500	500
1/2	1-1/2	6.06	6,000	1,200	4.76	4,300	860
5/8	2	10.3	10,000	2,000	8.0	6,700	1,340
3/4	2-1/4	13.9	14,000	2,800	10.5	9,000	1,800
7/8	2-3/4	20.0	19,000	3,800	14.28	11,500	2,300
1	3	24.4	24,000	4,800	18.1	14,000	2,800
1-1/8	3-1/2	33.3	30,000	6,000	22.22	17,000	3,400
1-1/4	3-3/4	38.4	35,000	7,000	26.7	19,000	3,800
1-1/2	4-1/2	55.5	50,000	10,000	36.3	27,500	5,500
1-5/8	5	66.6	62,000	12,400	45.45	33,000	6,600
1-3/4	5-1/2	80.0	75,000	15,000	55.5	40,000	8,000

*Note. Breaking strength and safe loads given are for new rope used under favorable conditions. As rope ages or deteriorates, progressively reduce safe loads to one-half of values given.

TABLE 8.—VARIOUS PROPERTIES OF MANILA
AND SYNTHETIC-FIBER ROPE.

Rope property	Manila	Nylon	Polyester	Polypropylene
Weight, pound/foot (1/2 inch diameter)	0.075	0.056	0.065	0.042
Abrasion resistance	Fair	Excellent	Good	Good
Impact resistance	Poor	Excellent	Good	Good
Fatigue resistance	Fair	Excellent	Excellent	Good
Elongation (at 20 percent breaking strength)	3 per- cent	23 percent	9 percent	14 percent
Melting or charring temperature, ° F	380	410	410	320
Low-temperature use	Good (dry)	Good	Good	Good
Water absorption	High	Low	Nil	Nil
Resistance to:				
Rot and mildew	Poor	Excellent	Excellent	Excellent
Acids	Poor	Fair	Good*	Excellent
Alkalies	Poor	Excellent	Good	Excellent
Sunlight	Fair	Fair	Good	Fair
Electrical resistance	Good (dry)	Excellent	Excellent	Excellent

*Disintegrated by concentrated sulphuric acid.

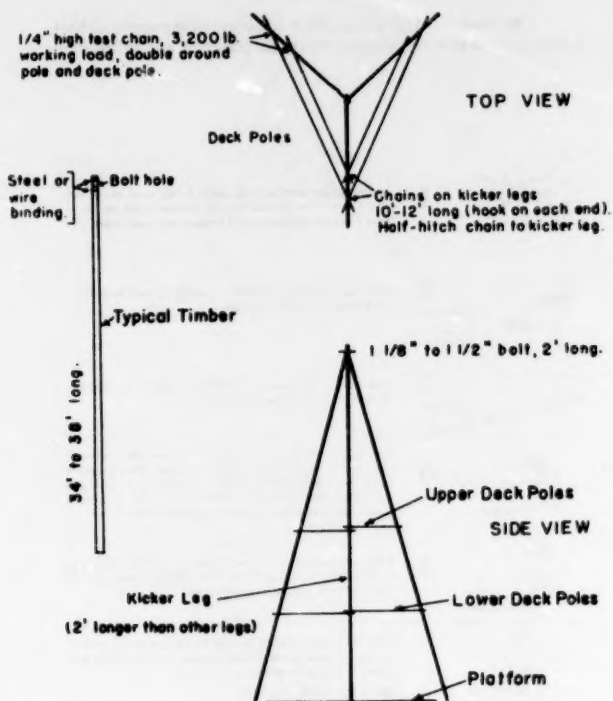


FIGURE 1.—TYPICAL TRIPOD

Application. Use this method not only on drowning victims, but on persons suffering electric shock, gas poisoning and suffocation.

	1 Examine victim's mouth for foreign matter. If there is any, (mucus, food, sand, tobacco, loose dentures, etc.) turn his head to one side and remove it with your fingers or a cloth wrapped around your fingers.
	2 Lift the victim's neck, place a folded coat, blanket, etc. under his shoulders. Tilt his head back as far as possible.
	3 Grasp the jaw with thumb in one side of the mouth and pull it forward. Maintain this position to keep air passage open.
	4 Pinch victim's nostrils shut, take a deep breath and place your mouth over his mouth and your thumb creating a tight seal; or close the victim's mouth, take a deep breath and place your mouth over his nose. Blow into victim's mouth or nose until you see his chest rise. For an infant breathe through both nose and mouth, with thumb in mouth.
	5 Remove your mouth and listen for out-flow of air. For an adult, inflate lungs at rate of about 12 times per minute. For a child, inflate lungs up to 20 times per minute, using relatively shallow breaths.
	○ If first few attempts to inflate the lungs are unsuccessful, turn victim on his side and administer several sharp blows between the shoulders in an attempt to dislodge the obstruction. NOW REPEAT ENTIRE PROCEDURE.

FIGURE 2.—MOUTH-TO-MOUTH RESUSCITATION

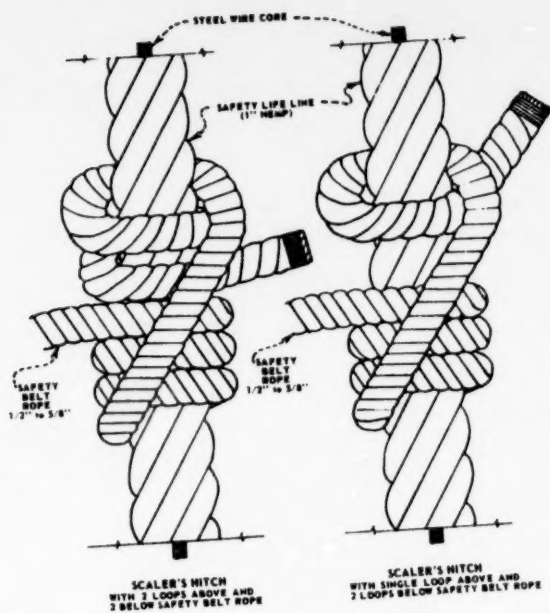


FIGURE 3.—SCALER'S HITCH (PIGTAIL).

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